

Special Publication No. 15-13

Summary of the Interagency Crab Research Meeting Held December 12, 2012, and Updated Research Priorities for Red King Crab in Alaska

by

Joel Webb

April 2015

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Measures (fisheries)	
centimeter	cm	Alaska Administrative		fork length	FL
deciliter	dL	Code	AAC	mideye-to-fork	MEF
gram	g	all commonly accepted		mideye-to-tail-fork	METF
hectare	ha	abbreviations	e.g., Mr., Mrs., AM, PM, etc.	standard length	SL
kilogram	kg			total length	TL
kilometer	km	all commonly accepted			
liter	L	professional titles	e.g., Dr., Ph.D., R.N., etc.	Mathematics, statistics	
meter	m	at	@	<i>all standard mathematical</i>	
milliliter	mL			<i>signs, symbols and</i>	
millimeter	mm	compass directions:		<i>abbreviations</i>	
		east	E	alternate hypothesis	H _A
		north	N	base of natural logarithm	<i>e</i>
		south	S	catch per unit effort	CPUE
		west	W	coefficient of variation	CV
		copyright	©	common test statistics	(F, t, χ^2 , etc.)
		corporate suffixes:		confidence interval	CI
		Company	Co.	correlation coefficient	
		Corporation	Corp.	(multiple)	R
		Incorporated	Inc.	correlation coefficient	
		Limited	Ltd.	(simple)	r
		District of Columbia	D.C.	covariance	cov
		et alii (and others)	et al.	degree (angular)	°
		et cetera (and so forth)	etc.	degrees of freedom	df
		exempli gratia		expected value	<i>E</i>
		(for example)	e.g.	greater than	>
		Federal Information		greater than or equal to	≥
		Code	FIC	harvest per unit effort	HPUE
		id est (that is)	i.e.	less than	<
		latitude or longitude	lat. or long.	less than or equal to	≤
		monetary symbols		logarithm (natural)	ln
		(U.S.)	\$, ¢	logarithm (base 10)	log
		months (tables and		logarithm (specify base)	log ₂ , etc.
		figures): first three		minute (angular)	'
		letters	Jan,...,Dec	not significant	NS
		registered trademark	®	null hypothesis	H ₀
		trademark	™	percent	%
		United States		probability	P
		(adjective)	U.S.	probability of a type I error	
		United States of		(rejection of the null	
		America (noun)	USA	hypothesis when true)	α
		U.S.C.	United States	probability of a type II error	
			Code	(acceptance of the null	
		U.S. state	use two-letter	hypothesis when false)	β
			abbreviations	second (angular)	"
			(e.g., AK, WA)	standard deviation	SD
				standard error	SE
				variance	
				population	Var
				sample	var
Weights and measures (English)					
cubic feet per second	ft ³ /s				
foot	ft				
gallon	gal				
inch	in				
mile	mi				
nautical mile	nmi				
ounce	oz				
pound	lb				
quart	qt				
yard	yd				
Time and temperature					
day	d				
degrees Celsius	°C				
degrees Fahrenheit	°F				
degrees kelvin	K				
hour	h				
minute	min				
second	s				
Physics and chemistry					
all atomic symbols					
alternating current	AC				
ampere	A				
calorie	cal				
direct current	DC				
hertz	Hz				
horsepower	hp				
hydrogen ion activity	pH				
(negative log of)					
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

SPECIAL PUBLICATION NO. 15-13

**SUMMARY OF THE INTERAGENCY CRAB RESEARCH MEETING
HELD DECEMBER 13-14, 2012, AND UPDATED RESEARCH
PRIORITIES FOR RED KING CRAB IN ALASKA**

by

Joel Webb

Alaska Department of Fish and Game, Division of Commercial Fisheries,
Juneau

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

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Joel Webb

*Alaska Department of Fish and Game, Division of Commercial Fisheries,
Headquarters Office, 1255 W. 8th St. P.O. Box 115526, Juneau AK, USA*

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PURPOSE

This report summarizes the 17th annual interagency crab research meeting, held December 13 and 14, 2012, in Kodiak, Alaska, at the Best Western Kodiak Inn. The interagency crab meetings began in 1993 and are held annually as prescribed in the *State/Federal Action Plan for Management of Commercial King and Tanner Crab Fisheries* (revised March, 2006, and available from the authors), an agreement between the National Marine Fisheries Service and the Alaska Department of Fish and Game. One objective of the interagency crab research meeting is the review, development, and prioritization of research topics. The special topic of the 2012 meeting was an extensive review of recent research progress and discussion to identify priority research directions for red king crab (*Paralithodes camtschaticus*) in Alaska. Researchers contributed talks to four themes: population estimation, stock productivity, stock structure, and harvest. This meeting continued the tradition of providing an informal opportunity for researchers from each of the active crab research centers to present their work on Alaska crab species among peers.

Key words: Alaska crab research, red king crab, *Paralithodes camtschaticus*, blue king crab, *Paralithodes platypus*, golden king crab, *Lithodes aequispinus*, Tanner crab, *Chionoecetes bairdi*, snow crab, *Chionoecetes opilio*, Dungeness crab, *Cancer magister*, stock assessment, research priorities

PARTICIPANTS

The 2012 meeting was attended by approximately 60 participants representing the Alaska Department of Fish and Game (ADF&G), the National Marine Fisheries Service (NMFS), the Norton Sound Economic Development Corporation, the School of Fisheries and Ocean Sciences of the University of Alaska Fairbanks (UAF), and the University of Alaska Southeast (UAS). A list of participants and contact information is included in Appendix 1.

PRELIMINARIES

The meeting was jointly chaired by Chris Siddon and Bob Foy, and audiovisual operations were run by Joel Webb. Following introductions and welcoming remarks, the draft agenda (Appendix 2) was adopted without change.

ACKNOWLEDGEMENTS

The authors thank the presenters for providing us with electronic copies of their slide presentations, allowing us to faithfully summarize the material presented. The author of this report accepts responsibility for errors in interpretation where a presentation abstract was not submitted or review of the presentation summary by the presenter was not available at the time of publication.

SUMMARY OF PRESENTATIONS

The order of presentations followed the agenda (Appendix 2), which was organized by the themes of the topic session and then by agency (University of Alaska, ADF&G, and NMFS).

SPECIAL TOPIC: WHAT ARE THE PRIMARY BIOLOGICAL AND ECOLOGICAL FACTORS AND KEY UNCERTAINTIES ASSOCIATED WITH VARIABILITY IN ABUNDANCE OF RED KING CRAB?

Speakers were invited to address this question in four themes: population estimation, stock productivity, stock structure, and mortality and to identify priority research items within each.

1. Population Estimation

Population estimation of Pribilof Islands red king crab

Dr. Bob Foy, National Marine Fisheries Service, Alaska Fisheries Science Center, Kodiak Laboratory, Kodiak, Alaska

The population estimate for red king crab (*Paralithodes camtschaticus*) in the Pribilof Islands is based on the area-swept index of abundance from the annual bottom trawl survey. The abundance index indicates low abundance of red king crab in the Pribilof Islands area prior to 1990, followed by a peak in abundance in the mid-1990s and higher but variable abundance in subsequent years. The variance of the abundance estimate is high since most crab are caught in a few tows and sampling density is sparse relative to the area sampled. Blue king crab (*Paralithodes platypus*) are co-distributed with red king crab in the Pribilof Islands and formerly sustained an important commercial fishery that has been closed since the late 1990s. Declining abundance of blue king crab appears to be coincident with increasing abundance of red king crab. Priority research items for Pribilof Islands red king crab are to 1) address possible survey catchability; 2) improve understanding of the roles of habitat availability, oceanography (larval drift), and interspecific interactions of red and blue king crab in recruitment variability; and 3) explore methods to integrate both pot and trawl survey data despite the high variance of each.

What we need for Bristol Bay red king crab: stock assessment viewpoints

Jie Zheng, Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau, Alaska

The Bristol Bay stock of red king crab supports the largest fishery for this species in Alaska. The stock assessment uses a length-based model which integrates data from fishery and fishery-independent monitoring with information on growth, maturity, and natural mortality. Research priorities for improving the stock assessment of Bristol Bay red king crab include improvement in 1) understanding of recruitment dynamics and survival rates from the larval stage to sizes observed in trawl surveys; 2) data for female growth and potential changes in male molting probability over time; 3) understanding of functional maturity of males and female size at maturity; 4) estimates of natural mortality and handling mortality rates, particularly in the early 1980s; 5) unobserved impacts of groundfish trawling; 6) understanding of survey selectivity, availability, and catchability and possible variation in these factors under varying environmental conditions.

The other Bering Sea red king crab – Norton Sound

Jenefer Bell, Alaska Department of Fish and Game, Division of Commercial Fisheries, Arctic-Yukon-Kuskokwim Region, Anchorage, Alaska

The Norton Sound stock of red king crab is the northernmost stock with fishable abundance. Harvest data is available back to 1977. The summer fishery is limited to small vessels and a smaller commercial and subsistence through-the-ice fishery during the winter. Available information on male maturity and growth used to set the harvestable size was collected in the late 1970s. Fluctuations in abundance appear

to be lower than other stocks in Alaska. Abundance is predicted with prerecruit abundance estimates from a triennial trawl survey and an annual winter through-the-ice pot survey. Key factors—for which limited information is available—include molt timing, habitat by life stage, and timing and location of reproduction. The spatial extent of historic sampling has been limited to specific areas. A summer pot survey, with a transect sampling design parallel to the shoreline at distances of 5 and 10 miles offshore, and improved coverage of eastern Norton Sound, has recently been implemented. Other concerns for the stock include observations of legal size males with erosion of the carapace spines for unknown reasons, and observations of another large lithodid crab, the spiny king crab (*Paralithodes rathbuni*), in the Bering Strait region. Priority research items for this stock include 1) annual trawl survey to validate prerecruit abundance, 2) the influence of environmental variability (storms, ocean acidification, warming) on productivity, and 3) possible impacts of gold dredging on survival and habitat of juvenile crab.

The Southeast Alaska red king crab fishery and collaborative efforts with the commercial fishing industry to improve stock assessment

Adam Messmer and Chris Siddon, Alaska Department of Fish and Game, Division of Commercial Fisheries, Douglas, Alaska

The southeastern Alaska red king crab fishery is managed with a regionwide minimum stock size threshold and area-specific harvest rates of up to 20% of mature male biomass. Fishery-independent monitoring occurs through an annual pot survey, and biomass estimates are calculated from a three-stage catch-survey analysis model. Southeast Alaska is a complex system of fjords, bays, and connecting waterways, and red king crab occur in all these locations. Pot survey sampling effort is allocated by density strata within the survey locations based on historical survey catch of males and females. Recent survey improvements have included expansion of survey sampling based on observations of catch outside surveyed areas and increasing sampling effort. The fishery has been repeatedly closed in recent years due to low estimated abundance; commercial catch and survey abundance have been in a monotonic decline, and a high proportion (52% in 2012) of the catch came from areas that are not surveyed. Red king crab are also targeted by a personal use fishery which opens in some locations when the commercial fishery has closed.

In cooperation with the commercial fishing fleet, a mark–recapture study was undertaken to provide an independent population estimate of the biomass for comparison with the model estimates used for management. Fishery closures have not resulted in increased abundance of red king crab and anecdotal information from other crab fisheries suggested that the geographic extent of survey location may not adequately cover the areas occupied by king crab. Legal-size male red king crab were marked and recaptured within a 2-month window in 8 of 9 survey areas. Sampling effort was also much higher in the mark–recapture studies versus the standard survey—sometimes by a factor of 10. The mark–recapture population biomass estimate was higher than the model estimate in all of the areas studied. The daily cost of performing the mark–recapture survey was slightly higher than the standard survey but the CPUE was less than half. Mark–recapture studies are too time intensive to perform on an annual basis in every location, and methods need to be developed for integrating mark–recapture biomass estimates into setting harvest levels.

Primary research priorities for red king crab in Southeast Alaska include 1) the need to understand factors contributing to the poor recruitment indicated by a regionwide decline in abundance, 2) a biological threshold for management, 3) lack of a defined strategy for allocation of harvest between

commercial and personal use fisheries, and 4) limited knowledge of the level of personal use harvest in much of the region.

2. Stock Productivity

Bristol Bay red king crab fecundity, embryo quality, and larval quality: What we know and don't know

Kathy Swiney, National Marine Fisheries Service, Alaska Fisheries Science Center, Kodiak Laboratory, Kodiak, Alaska

Stock assessment of red king crab can be improved by incorporating reproductive output, which requires an understanding of the size-fecundity relationship, interannual and seasonal variability in fecundity, embryo viability, maternal size effects on embryo and larval quality, and annual variability in embryo quality. We collected egg clutches from Bristol Bay, Alaska, in the summers of 2007 to 2010, 2012, and autumn of 2007, 2008, and 2009, and estimated fecundity and embryo viability. In 2009 and 2010, embryo quality based on dry weight and carbon and nitrogen content was assessed. In 2008, larval quality based on dry weight, carbon and nitrogen content, and time to 50% mortality under starvation conditions was assessed. Fecundity increased with female size up to approximately 138 mm carapace length (CL), after which the slope decreased by 40%, suggesting senescence, as clutches were on average 100% viable. Slight ($\leq 5\%$) but statistically significant variations in fecundity were observed among years. Fecundity was consistently lower in fall than spring, suggesting brood loss, with a 6% decrease between seasons in females smaller than 138 mm CL, and 10% decrease in larger females. In 2012, the slope decreased by 20% for females smaller than 108 mm CL, which was not previously observed. We attribute the change in slope in 2012 to the predominance of primiparous females in samples of females smaller than 108 mm CL, whereas a mix of primiparous and multiparous females was sampled in this size range in previous years. Thus, the decrease in fecundity among small females suggests that primiparous females are less fecund than multiparous females. Among the measures of embryo quality, only nitrogen content significantly increased with maternal size. Carbon and nitrogen content were significantly higher for embryos in 2009, suggesting interannual differences in maternal investment. Larval quality did not vary with maternal size, suggesting that differences in embryo nitrogen content may not equate to increased larval quality. When incorporating reproductive output in stock assessment, variation in the size-fecundity relationship should be incorporated, but variations in embryo and larval quality are small and therefore not critical for inclusion during assessment. Our study was conducted in colder than average years in Bristol Bay, therefore we are cautious to extrapolate our results to years with different environmental conditions.

Effects of ocean acidification on red king crab embryos, larvae, and juveniles

W. Christopher Long (presenting author), Katherine M. Swiney, and Robert J. Foy, National Marine Fisheries Service, Alaska Fisheries Science Center, Kodiak Laboratory, Kodiak, Alaska

Rising levels of atmospheric CO₂ lead to rising levels in oceanic water, as much of the CO₂ is absorbed by the ocean. This increase in CO₂ concentrations has led to ocean acidification (OA), or a decrease in the pH of ocean water, which can affect survival, calcification, reproduction, and morphology of organisms living in the water. Species with calcified shells or exoskeletons, such as crabs, may be particularly vulnerable. We held ovigerous red king crab in acidified, pH 7.8, and control seawater for 3 months prior to hatching, and juveniles in pH 7.5, 7.8, and control seawater for 7 months. Embryos were photographed monthly for morphometric analysis. After hatching, larvae were collected and held in acidified and control seawater to quantify the effects of OA on larval survival and calcium content. We

crossed maternal treatment with larval treatment to examine interactions between the effects of OA at the embryo and larval stages. Larvae were also photographed for morphometric analysis. Juvenile survival and growth were monitored throughout the experiment and the condition index (dry mass/carapace length³) and calcification were determined at the end. Embryo morphometry changed with time; embryo size and eyespot size increased, and yolk size decreased, as the embryos developed. Embryos held in acidified waters were larger, had smaller yolks and larger eyespots than embryos held in control water. Exposure to acidified water, both as embryos and as larvae, decreased survival time for starved larvae. Larvae that hatched from embryos held in acidified water were morphometrically different from those held in control water and in general were slightly larger. Larvae held in acidified water had a higher calcium content than larvae held in control water. Juvenile survival was decreased substantially in acidified water, with 100% mortality in the pH 7.5 treatment after about 90 days. Growth was slower in pH 7.8 water than in control. While calcium levels in the juveniles were unaffected by OA, the condition index of crabs in pH 7.8 water was lower than those in control water. Models of stock dynamics that incorporate these results show a closure of the fishery within 100 year under acidified conditions. We conclude that OA has a substantial effect on red king crab embryos and larvae and may negatively affect the stock through decreased larval survival and decreased juvenile growth and survival if CO₂ levels continue to rise unabated.

Predation of early benthic phase red king crabs

Ben Daly, National Marine Fisheries Service, Alaska Fisheries Science Center, Kodiak Laboratory, Kodiak, Alaska

Predation of early benthic phase red king crabs could create a population bottleneck, yet we know very little about population-level effects. Increases in eastern Bering Sea groundfish abundances in the late 1970s and early 1980s coincided with declines in Alaska red king crab populations, and gut content analyses show that groundfish prey on large, softshell juvenile red king crabs; however, correlations do not represent empirical evidence for predation mortality. Documentation of early benthic phase red king crabs is virtually nonexistent in stomach analyses, likely because samples are taken outside shallow nursery areas. Nearshore tethering studies demonstrate a diverse group of predators that includes juvenile flatfish, ronquils, sculpins, kelp greenling, hermit crabs, and sea stars, and laboratory studies show early benthic phase red king crabs are highly cannibalistic, yet the relative importance of these identified predators is unknown. This presentation provided an overview of the current state of knowledge with respect to predation of early benthic phase red king crabs, identified major questions that remain unanswered, discussed potential implications for assessment, and suggested areas of needed research. These included 1) nearshore gut content analyses, 2) size-specific predation susceptibility, 3) the role of Pacific cod predation, 4) cannibalism in the wild, and 5) mechanisms for recruitment limitation.

Advances and future directions in larval and juvenile king crab biology and ecology

Ginny Eckert, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, Juneau, Alaska

The early life history stages of marine invertebrates with planktonic larvae, including commercially important crabs, are generally thought to be when potential bottlenecks in production occur. Field and laboratory studies have been undertaken to identify factors that may influence production during the early life stages of king crabs. These factors include varying reproductive output, larval transport/supply, larval nutrition, metamorphosis (zoea to glaucothoe), predation of larval stages, predation of juveniles, and juvenile growth and habitat. *In situ* studies in Southeast Alaska suggested high spatial heterogeneity in larval supply, with differences not necessarily attributable to the abundance of mature females.

Analysis of lipid class and fatty acid profiles showed that marked differences exist between cultured and wild juvenile red king crabs. Field and laboratory studies also show ontogenetic shifts in behavior (cryptic/solitary to aggregation in pods) and habitat (rocky inter/subtidal to deeper and variable habitats), and high variability in growth rates (depending on temperature) for red king crabs during the early benthic stages. All these interacting factors play a role in red king crab survival. The Alaska King Crab Research, Rehabilitation, and Biology program, which has focused on cultivation of king crab for stock enhancement in Alaska, has provided a valuable platform for research into the processes determining survival in the early life history stages for red and blue king crab. Collaborations are also underway with scientists investigating similar processes for king crabs at high latitudes in South America.

Effects of climate and gadid predation on red king crab population dynamics in Alaska

Gordon Kruse, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, Juneau, Alaska

Climactic forcing and predation effects of gadid fishes have been proposed as mechanisms affecting the the population dynamics of red king crab. Data from three stocks in Alaska (Kodiak, Bristol Bay, and Norton Sound) were evaluated for evidence of the role these factors play in recruitment variability. Evidence of an observable Ricker stock-recruit relationship was lacking for all three stocks. For the Kodiak stock, very high fishing mortalities, observations of highly skewed sex ratios, and mature females, suggested that very high fishing mortality rates influenced stock productivity. Similarly, historic harvest rates in Bristol Bay greatly exceeded levels maintained under current harvest policy. In Norton Sound a pulse of high fishing mortality rates occurred in the early 1980s but generally low harvest rates since that period have been associated with stable stock biomass. Temporal variation in the logarithm of recruits-per-spawner among stocks suggested decadal patterns of stock productivity for Kodiak, and stock-recruit relationships for all stocks have a strong autocorrelated signal and evidence for density-dependence, which seems to vary in relationship to the Pacific decadal oscillation (an index of climactic variability). Potential mechanisms for interactions between climate variability and recruitment include 1) water column stability, which is associated with strong *Thalassiosira* spp. diatom blooms (an important dietary component for larval red king crab), 2) the effects of bottom temperature on female distribution and the timing of larval release, and 3) whether cool years deliver larvae to suitable habitats along the north side of the peninsula. Paradoxically, there are also indications of broad association between fish abundance and crab recruitment but little empirical evidence to support this observation, suggesting the need for further investigation.

Report on the qualitative modeling workshop on red king crab recruitment and potential climate change impacts

Gordon Kruse, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, Juneau, Alaska

A workshop attended by experts in the red king crab biology and recruitment was held in Juneau in the summer of 2011. The group evaluated hypotheses regarding positive and negative impacts of climate change on red king crab recruitment at discrete stages of the life cycle. Results of this exercise were then operationalized in an model which can be used to evaluate likely scenarios. A summary of the workshop and modeling effort will be summarized in a forthcoming peer-reviewed publication.

3. Stock Structure

A short review of genetic studies of red king crab populations

W. Stewart Grant, Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage, Alaska, and David A. Tallmon, University of Alaska Southeast, Juneau, Alaska

Several molecular markers have been used to study populations of red king crab in the North Pacific and Bering Sea. Allozymes markers did not adequately resolve population structure because only a few polymorphic loci could be found, and because natural selection on allozyme variants may have obscured demographic processes. Microsatellites are assumed to be less subject to natural selection, and population analyses with these markers showed differences on small geographic and allele-frequency shifts over a few generations, reflecting genetic drift in small populations. Microsatellite analysis of individual broods did not find evidence for multiple paternity. Mitochondrial DNA markers show genetic footprints of long-term demographic history in addition to population structure. Lastly, the results for single nucleotide polymorphisms have largely been consistent with other markers, but ascertainment bias has led to the inability to address some questions of importance to both evolutionary biologists and fishery managers. Together, these markers depict three major evolutionary lineages across the North Pacific, each with characteristic levels of gene diversity. Significant population structure within these lineages reflects isolation forced by shoreline complexity and ocean currents that shape patterns of gene flow between populations. These molecular makers can be used to aid in the development of broodstock and in the evaluation of the success of stock enhancement. Priority research directions for future genetic work will focus on parentage analysis to track the reproductive success of crabs released into the wild and on genome-wide molecular analysis to better understand the basis of local adaptation.

4. Harvest Mortality

Ghost fishing on king crab in Womens Bay

Pete Cummiskey and Chris Long (presenting author), National Marine Fisheries Service, Alaska Fisheries Science Center, Kodiak Laboratory, Kodiak, Alaska

Womens Bay near Kodiak, Alaska, has supported commercial, subsistence, and personal use fisheries for king, Tanner, and Dungeness crab for many years, with numerous crab pots lost in that time. Since these derelict pots have the potential to *ghost fish* (i. e., capture crab in unattended pots) and cause a substantial mortality to juveniles and adult crab of both sexes, including ovigerous females, they may affect the reproductive potential of the stock, which has been depressed since the early 1980s. Biologists at the National Marine Fisheries Service Kodiak Lab use acoustic tags and scuba to document crab movement, habitat use, and behavior of red king crab in Womens Bay. Tags allow long-term monitoring of pods of up to thousands of crab. Between 1990 and 2008, on nearly 10% of 614 dive observations, the tagged crab were on or in derelict pots. Sixty derelict pots were observed, including 31 Dungeness, 21 other commercial types, 4 homemade, and 8 unknown. Sixty-five percent of these pots were intact and capable of ghost fishing. Twenty-six tagged crab, and hundreds of nontagged crab, were trapped in intact ghost fishing pots, with 12 tagged crab, including 4 mature females, found dead. Divers routinely disable ghost pots and have released hundreds of crab, many mature. We estimate that ghost fishing likely kills between 6% and 12% of king crab per year in Womens Bay and may reduce the ability of the local crab population's ability to rebuild.

Red king crab and trawls: Gear impacts and bycatch mortality

Craig Rose, National Marine Fisheries Service, Alaska Fisheries Science Center, Sand Point Laboratory, Seattle, Washington

Two important factors affecting interactions between red king crab and trawls are the configuration of the trawl gear and the spatiotemporal overlap of crabs and trawl effort. Major components of trawls include the door, sweep, and net. The majority of trawl bottom contact is due to sweeps (86%), followed by the net (12%) and doors (2%). For flatfish trawlers there are many techniques in net development that decrease crab catch and mortality by raising the sweeps and footrope off the bottom. Mortality rates of red king crab from contact with the various components of the trawl gear were evaluated by deployment of gear in the field and reflex impairment and injury assessment of encountered individuals. A 31% mortality rate was estimated for the sides of the footropes (wing), a 16% mortality rate was estimated for the footrope center, and a 10% mortality rate was estimated for the sweeps. Experimental treatments to increase the height of the trawl sweeps off the bottom lowered mortality rates by half. Aerial exposure time was an important predictor of mortality for observed bycatch. Priority research directions for further understanding the impacts of trawling on red king crab mortality include 1) evaluation of crab bycatch in pollock trawls fished on the bottom, 2) seasonal dynamics of crab distribution and how these interact with seasonal closures of trawling (data exist to evaluate the spatiotemporal impact of trawling on a cell-specific basis, but crab life history is more difficult to account for), 3) estimates of bycatch mortality rates that reflect current practices (recent and historical work has improved knowledge of the overall role various components of trawling play in crab mortality, but more research is needed), and 4) further need to quantify unobserved mortality.

CONTRIBUTED TALKS

Tamone Crab Lab: Update on bycatch mortality and terminal molt in *Chionoecetes*

Sherry Tamone, University of Alaska Southeast, Biology Department, Juneau, Alaska

Molting and gonad development are hormonally controlled in all crab, with trade-offs between energetic investment in molting and reproductive investment (molting can reduce reproductive potential). High ecdysteroid levels are associated with the energetically intensive process of synthesis of new exoskeleton. Research has been focused on identifying factors associated with the decision to terminal molt or not. Peaks in circulating ecdysteroid levels indicate that there is a premolt period of approximately 18 weeks in male Tanner crab. No difference in peak ecdysteroid levels were observed between animals that molted to maturity (large-claw) and those that retained adolescent characteristics. Analysis of methyl-farnesoate levels in these individuals may reveal potential differences. The next step is to measure methyl-farnesoate from these samples. Freezing exposure of the eyestalks reduced circulating glucose to about half that of controls—a 10-minute freezing exposure led to reduced circulating glucose for exposed crab, and the Reflex Action Mortality Predictor method indicated higher mortality for these crab.

Population structure and trophic position of snow crab (*Chionoecetes opilio*) in the Alaskan Arctic: contributing to stock assessment data for the Arctic Fisheries Management Plan

Lauren Divine, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, Fairbanks, Alaska

The increase in human impacts that come with oil and gas exploration and fishing, combined with the warming and loss of sea ice in the Arctic Ocean, mean we are going to need better information on

abundance, distribution, and life history of the commercially valuable snow crab. Snow crab data from several research cruises in the Chukchi and Beaufort seas regions was used to estimate life history parameters and trophic positioning. Paired tows between trawls (beam trawl and 83-112) were conducted in the Chukchi Sea in 2012 to establish a comparison between sampling techniques in the Arctic and standard techniques used in the eastern Bering Sea. Large male and female snow crabs, similar in size to those observed in the eastern Bering Sea, were found in warm waters associated with deeper depths (>100 m) in the Beaufort Sea. In contrast, no large crab were observed regardless of depth in the Chukchi Sea. Further objectives of this study will be to complete gear and estimated life history parameters to strengthen input to the Arctic Fishery Management Plan.

Kings or Zombies? A review of parasitic barnacles infecting king crabs and future research questions

Leah Sloan, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, Fairbanks, Alaska

Parasitic castrators cause the genetic death of their hosts, yet the hosts survive and compete for space and resources with noninfected members of their own species. As a result, parasitic castration puts more stress on host populations than an equivalent amount of predation. The rhizocephalan barnacles are parasitic castrators that primarily infect decapod crustaceans, including many commercial species. In Alaska the parasitic barnacle *Briarosaccus callosus* infects all three species of commercially harvested king crabs (red, blue, and golden). High prevalence of *B. callosus* could greatly reduce the harvestable biomass and make commercial fisheries unsustainable in certain areas. This project is interested in studying the prevalence and distribution of *B. callosus* in king crabs around Alaska, including explanations for spatial and temporal prevalence shifts. This project is also interested in the factors that influence whether or not a crab will become infected, which include may size, sex, immune response, injury, and water clarity.

Effects of ocean acidification on larval development of Alaskan crabs

Raphaelle Descoteaux, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, Fairbanks, Alaska

Increasing atmospheric carbon dioxide levels will result in acidification of the ocean with implications for calcifying marine organisms including crab. High-latitude waters such as the Gulf of Alaska may be more vulnerable to ocean acidification due to thermal, primary production, and freshwater input dynamics. Acidification can impact crab in diverse ways, affecting development, morphology, gene expression, mineralization of the exocuticle, and behavior. We held posthatchzoeae of Tanner and Dungeness crab at 3 pH levels (8.1, 7.9, and 7.6) in the laboratory for 2 weeks and examined the effect of duration of exposure at pH on zoeal, size, weight, and survival. Preliminary results showed no difference in survival rates, rostral spine length, or weight of Dungeness zoeae among treatments. While zoeal weight did not vary among treatments for Tanner crab, zoeae at the lowest pH treatment were significantly smaller in a suite of spine and body size measures, which could have implications for predation survival and buoyancy. Further objectives of this project will be to run further experiments on additional crab species and to quantify potential mineralization differences in the zoeal exoskeleton as a function of pH exposure.

Interannual variability in transport and connectivity patterns of eastern Bering Sea Tanner crab

Jon Richar, University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, Juneau, Alaska

Abundance and harvest of eastern Bering Sea Tanner crab are subject to large-scale fluctuations likely due to factors affecting the crab's early life history stages. A three-dimensional oceanographic model

(Regional Ocean Modeling System) was used to investigate the potential role of larval transport (metapopulation structure) in these fluctuations. Larvae were modeled as passive particles with no diel vertical migration and a 60-day larval period. Larvae were released from April to early June from locations determined by the distribution of mature female Tanner crab observed in summer bottom trawl surveys. Model results showed long-term changes in transport-forcing variables; larvae were either retained or transported to adjacent region rather than being transported for long distances. High retention rates were observed in all major source regions and retention rates increased with depth. Transport rates may have been overestimated due to our not incorporating larval vertical migration. The strongest connectivity was observed occurring between populations in the same domain, with the dominant exchange vector being northwesterly and along-shelf while the strongest cross-shelf connectivity was on-shore and once more between adjacent regions. Our results suggest that larval supply to Bristol Bay may be primarily dependent on retention of locally produced larvae, which have necessarily been reduced with the population decline. This in turn suggests that limitation of larval supply may be at least a component in the stock's inability to recover. Due to its importance as a settlement region, the southern middle domain of the eastern Bering Sea shelf may at present be particularly important to recruitment trends for this stock. These findings also support managing the fishery for this species as two stocks east and west of 166°W. Limited or anomalous cross-shelf transport may allow sufficient genetic exchange to explain the ambiguity observed in genetics studies, which have not conclusively supported the existence genetic differentiation between areas.

Mapping Tanner crab habitat in the Gulf of Alaska

Carrie Worton, Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak, Alaska

Alaska Department of Fish and Game manages commercial fisheries for Tanner crabs in the Gulf of Alaska and conducts annual bottom trawl surveys to assess the populations and provide data to set harvest limits. Bottom trawling is limited to trawlable habitat that comprises only a proportion of the total survey area. The current practice of expanding Tanner crab densities from trawlable habitat to large areas of unknown habitat can potentially create bias in overall population estimates; this is critical because state regulations require that population estimates exceed a lower threshold before opening Tanner crab fisheries. For a benthic species like Tanner crab, understanding the relationships between habitat and abundance is essential for extrapolating population density estimates to larger scales. The goal of this project is to map and describe important Tanner crab habitat northeast of Kodiak Island in the Gulf of Alaska. For the first time, we used Wide Angle Sonar Seafloor Profiler multibeam sonar and a towed benthic imaging system to deliver full-coverage maps of bathymetry and seafloor acoustic backscatter and to provide both classified substrates and biological observations for Tanner crab habitat. We hypothesize that Tanner crabs have preferred habitats and are associated with specific bottom characteristics that can be recognized in data collected by a multibeam sonar system: substrate, biota, and geomorphologic characteristics (depth, hardness, slope, rugosity). This information will be used to increase understanding of the spatial distribution of Tanner crab and their habitat and will aid in interpretation of stock assessment data.

An experimental escapement based management system for Alaska pot shrimp fisheries

Quinn Smith, Alaska Department of Fish and Game, Division of Commercial Fisheries, Douglas, Alaska

Limited ability to quickly adjust harvest levels in response to population fluctuations and declining harvest and abundance of shrimp in Southeast Alaska (SEAK) are management concerns. In contrast, shrimp harvests in British Columbia (BC) increased in recent years, and harvest is controlled using an

inseason fishery pot CPUE index for egg-carrying females relative to values determined from research on productivity of an unexploited stock. The fishery closes when the index reaches a location-specific threshold CPUE. Development of similar methods was explored in Southeast Alaska (SEAK). First, the 2 sizes of shrimp pots used in the SEAK were fished concurrently to estimate differences in CPUE compared to pots used in British Columbia (BC), and the results of this experiment were used to set the threshold CPUE by month for SEAK relative to that determined for BC. A vessel was then chartered and pots were sampled aboard commercial vessels on the fishing grounds in 3 harvest districts to examine temporal trends in fishery CPUE. Clear decreasing temporal trends in egg-carrying female CPUE were not observed in all districts sampled and also varied among districts sampled. Further work is underway to advance understanding of shrimp reproductive biology and the factors important to determining minimum threshold CPUE levels that may differ between BC and SEAK.

Norton Sound red king crab summer commercial fishery catch-per-unit-effort standardization

Gretchen Bishop and Shareef Siddeek, Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau, Alaska

The stock assessment model for Norton Sound red king crab incorporates both fishery-dependent and fishery-independent data. Since the trawl survey for this stock occurs on a triennial basis, the assessment model is particularly dependent on CPUE data from pot surveys and the fishery. The summer commercial fishery in Norton Sound has undergone important historical changes in management, from a large- to small-vessel fishery, which likely influences the interpretability of fishery CPUE. We investigated standardization of fishery CPUE and associated uncertainty by factors including year, vessel size, location of harvest, time of fishing within year, and other variables using the generalized linear model. Vessel size, the timing of fishing within year, and an interaction factor between these 2 variables, were significant predictors of log CPUE. Standardized CPUE was lower than mean fishery CPUE during the time period of the large vessel fishery and higher than mean fishery CPUE since the transition to small vessels. Model-standardized CPUE should result in increased precision of the Norton Sound stock synthesis model and further improvement may be possible with inclusion of environmental variables influencing CPUE.

Registration area D (Yakutat) Dungeness fishery and recent survey work

Joe Stratman, Alaska Department of Fish and Game, Division of Commercial Fisheries, Petersburg, Alaska

Commercial harvest of Dungeness crab in the Yakutat area fluctuated from less than 1 million up to 5 million pounds prior to closure due to consecutive years of very low abundance in 2000. Two pot surveys with similar methods and spatial distribution were conducted in the Yakutat area in 2004 and again 2012 to evaluate stock status. Catches were very low, and crab were found in few locations relative to the area surveyed in 2004, indicating a likely lack of recovery in abundance. In contrast, the pot catches per pot were much higher in 2012, and crab were present in most of the locations sampled in 2012, indicating a likely increase in stock abundance. Management of the Yakutat area Dungeness crab and similar crab stock is challenged by a lack of consistent indicators of stock health and associated criteria for opening and closing sport, personal use, and commercial fisheries.

A pilot study of commercial fishing gear selectivity during the 2012/13 Aleutian Islands golden king crab fishery

Vicki Vanek, Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak, Alaska

The fishery for golden king crab in the Aleutian Islands was rationalized in 2005, which resulted in changes in fishery CPUE and size-composition of both the observer and dockside (retained catch) sampling. The prohibitively high cost of surveying this remote and broadly distributed stock caused the cancellation of a fishery-independent triennial pot survey. While the fishery CPUE of legal-size males increased after rationalization, the CPUE of males in smaller size classes remained stable or decreased. Possible explanations of this pattern include recruitment failure, changes in fishing practices, or changes in the effectiveness of bycatch reduction measures that allow small crab to escape pot. To address this question, ADF&G, in cooperation with industry, deployed research pots designed to retain smaller crab during the fishing operations of a commercial vessel. CPUE and size-frequency were then compared between adjacent research pots and standard commercial pots within a string. Preliminary results show that the catch rate of sublegal males was approximately 7 times greater for research than commercial pots. These results demonstrate that small males are present on the fishing grounds, that changing fishery practices have likely resulted in the decreased catches of sublegal males, and that deploying research pots during the commercial fishery may be a cost-effective approach to obtaining data on this segment of the population.

Habitat, predation, and competition: Interactions between juvenile red and blue king crabs

W. Christopher Long, Scott B. Van Sant, and Jan A. Haaga, National Marine Fisheries Service, Alaska Fisheries Science Center, Kodiak Laboratory, Kodiak, Alaska

Red king crab and blue king crabs have a generally nonoverlapping distribution. Reasons for this may include differences in temperature tolerances, competition and differing levels of predation pressure. In the 1970s and 1980s, blue king crabs dominated in the Pribilof area of Bering Sea, but since the 1990s red king crabs have been dominant. This project performed a series of experiments to determine if competition between the 2 species at the juvenile stage might help to explain these observations. We performed habitat choice experiments on year-0 red and blue king crabs with sand, shell, and cobble habitats crossed with predator presence and year-0 density. We determined the effect of temperature and habitat on predation by year-1 red king crab on year-0 blue king crabs. Finally we performed a 12-week competition experiment holding red and blue king crabs both separately and together in shell and cobble habitat and monitored survival. Red king crab generally preferred complex habitat over sand and their preference was increased in the presence of predators, but they showed no preference in shell-cobble trials. Blue king crabs generally showed a preference for sand habitat with an increased preference for complex habitat in the presence of predators. Blue king crabs also preferred shell over cobble. Predation on year-0 blue king crabs was lower at 1.5°C than at 5°C or 8°C and was lower in shell and cobble than in sand. In the competition experiment, red king crab survived better in shell than in cobble, and better when blue king crab were present than when they were absent. Blue king crab, although they also survived better in shell than in cobble, had much lower survival in the presence of red king crab, particularly in cobble where they were extirpated within 9 weeks. We conclude that year-0 red king crabs have a competitive advantage over blue king crabs and that this interaction may be affecting blue king crab productivity in the Pribilof Islands stock.

Crabs of the Chukchi Sea

Dan Urban, National Marine Fisheries Service, Alaska Fisheries Science Center, Kodiak Laboratory, Kodiak, Alaska

The National Marine Fisheries Service conducted a survey of the Chukchi Sea during August and September of 2012. Sixty-one stations were sampled with the standard National Marine Fisheries Service 83-112 net, the same net used to survey the Bering Sea. Thirty-four stations were sampled with

a 12-foot wide beam trawl. The beam trawl catches were remarkably diverse with over 70 species being found in catches that were typically less than 100 kilograms. The beam trawl was especially effective at capturing young-of-year snow crab, with catches sometimes numbering over 20,000 crabs. Red and blue king crab catches were small. Only 2 red king crab and 31 blue king crab were captured. Snow crab, however, were commonly captured throughout the survey area. Over 4 million crabs were captured, but overall they were smaller than snow crab seen in the Bering Sea. No male snow crab of commercial size were seen.

POSTER PRESENTATIONS

Shellfish management aerial surveys using ArcPad 10 in Southeast Alaska

A. Olson and A. Messmer, Alaska Department of Fish and Game, Douglas, Alaska

King crab parasites in Alaska fjords: A population study

C. Nouver, University of Bergen, Bergen, Norway; C., A. Olson, Alaska Department of Fish and Game, Douglas, Alaska; and H. Glenner, University of Bergen, Bergen, Norway

PLANS FOR 2013

The annual Alaska crab research meetings continue to be productive and valuable for free exchange of scientific results, ideas, and perspectives. An 18th annual meeting is expected to be scheduled for the approximate dates of December 11–13, 2013, in Anchorage, Alaska.

PROPOSALS FOR NEXT YEAR'S SPECIAL TOPIC

1. Effectiveness of slot limits for management of crustacean fisheries
2. Effects of size-selective harvest on crab reproduction and recruitment
3. Ecosystem-based management and application to crab fisheries
4. New developments in harvest strategies for crustacean fisheries

RESEARCH PRIORITIES FOR RED KING CRAB IN ALASKA

This section summarizes research priorities for red king crab stocks in Alaska. These priorities were identified by managers/researchers during the topic session or during group discussion at the 2012 Interagency Crab Meeting and reviewed by stakeholders following the meeting. These priorities build on prior summaries for commercially important crab stocks in Alaska (Webb and Woodby 2011) and a workshop which identified hypothetical biological and oceanographic drivers of year-class strength for red king crab (Tyler and Kruse 1995, 1996).

POPULATION ESTIMATION

1. Improve understanding of survey selectivity, catchability, availability, variability, and their relationships with environmental conditions (e.g., bottom temperature) in Bristol Bay and Southeast Alaska.
2. Expand the spatial coverage, increase the frequency of, and develop estimates of precision for estimates of abundance from fishery-independent surveys in Norton Sound.
3. Evaluate survey catchability for the Pribilof Islands stock and methods of integrating pot survey and trawl survey data in assessment.

STOCK PRODUCTIVITY

1. Identify major predators (including conspecifics) during the early benthic phase, patterns of spatial and temporal overlap between predators and prey, and assess population-level effects of predation.
2. Conduct field studies on the role of larval supply versus predation in recruitment limitation by release and monitoring of early benthic phase juveniles.
3. Investigate the role of the timing of larval release relative to primary production and availability of *Thalassiosira* spp. Diatoms, which are a high quality food source for larvae and may influence larval survival.
4. Collect *in situ* measurements of pH in red king crab habitats to improve understanding of anthropogenic impacts and natural variability for all stocks.
5. Evaluate the scope of possible evolutionary response to ocean acidification.
6. Investigate the effects of ocean acidification on interactions among competitors and predators of red king crab.
7. Improve understanding of male functional maturity, female size at maturity, and variability in these parameters for Bristol Bay.
8. Identify covariates influencing recruitment variability and estimate survival rates from the larval stage to sizes observed in trawl surveys for Bristol Bay.
9. Incorporate variation in the size-fecundity relationship into indices of reproductive potential for the stock assessment of the Bristol Bay stock.
10. Investigate potential variation in embryo quality and size-fecundity between warm and cold regimes for Bristol Bay red king crab.
11. Improve understanding of interspecific interactions between red and blue king crab and their potential role in recruitment variability in the Pribilof Islands.
12. Evaluate the influence of habitat availability and larval transport on recruitment in the Pribilof Islands
13. Identify nursery habitats for red king crab in Norton Sound and further investigate the influence of gold dredging operations and environmental factors on recruitment.
14. Acquire additional data on variability in female growth, male molt probability, and important covariates in Bristol Bay and Norton Sound.
15. Improve knowledge of reproductive metrics for Norton Sound, including larval release timing, location of spawning grounds, operational sex ratio, and effective male spawning biomass.
16. Improve understanding of physical and biological factors influencing larval advection trajectories for red king crab stocks

STOCK STRUCTURE

1. Conduct genomic-wide molecular analysis to provide further understanding of the role of local adaptation and resilience to environmental variability and ocean acidification.
2. Develop parentage analysis to track reproductive success of cultured crabs released into the wild.

HARVEST MORTALITY

1. Investigate observed and unobserved impacts of groundfish trawling in Bristol Bay by evaluating historical patterns, recent patterns of bycatch in pollock trawls, and understanding how seasonal dynamics of distribution interact with time and area trawl closures.
2. Obtain gear-specific estimates of bycatch mortality rates that reflect current practices, and continue efforts to quantify unobserved mortality for both Bristol Bay and Norton Sound.

3. Develop a biological threshold for management and a defined strategy for allocation of harvest between commercial and personal use fisheries in Southeast Alaska.
4. Estimate natural and handling mortality rates, particularly in the 1980s for Bristol Bay.
5. Improve knowledge of personal use harvest in Southeast Alaska.
6. Initiate and improve efforts to monitor and mitigate effects of ghost fishing of derelict crab pots which can contribute significantly to mortality.

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- Webb, J. B., and D. Woodby. 2011. Long-term Alaska crab research priorities, 2011. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J11-04, Juneau.

APPENDIX

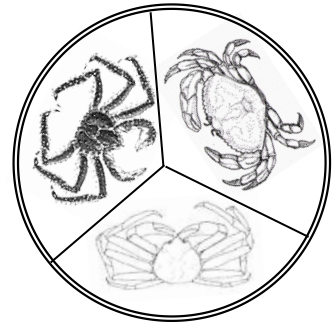
Appendix A.–List of participants at the 2012 Interagency Crab Research Meeting.

Last Name	First Name	Affiliation	Location	Email
Armistead	Claire	NMFS	Kodiak	claire.armistead@noaa.gov
Baechler	Britta	ADF&G	Dutch Harbor	britta.baechler@alaska.gov
Baer	Rob	ADF&G	Kodiak	robert.baer@alaska.gov
Barnard	David	ADF&G	Kodiak	david.barnard@alaska.gov
Bishop	Gretchen	ADF&G	Douglas	gretchen.bishop@alaska.gov
Bell	Jenefer	ADF&G	Nome	jenefer.bell@alaska.gov
Burt	Ryan	ADF&G	Dutch Harbor	ryan.burt@alaska.gov
Daly	Ben	NMFS	Seward	ben.daly@alaska.edu
Dawson	Matt	NMFS	Kodiak	matt.dawson@noaa.gov
Descoteaux	Raphaelle	UAF	Fairbanks	rdescoteaux@alaska.edu
Divine	Lauren	UAF	Fairbanks	ldivine@alaska.edu
Donaldson	Wayne	ADF&G	Kodiak	wayne.donaldson@alaska.gov
Eckert	Ginny	UAF	Juneau	ginny.eckert@alaska.edu
Evans	Eric	ADF&G	Dutch Harbor	eric.evans@alaska.gov
Foy	Bob	NMFS	Kodiak	robert.foy@noaa.gov
Gabriel	Nikki	ADF&G	Homer	nikki.gabriel@alaska.gov
Grant	Stewart	ADF&G	Anchorage	william.grant@alaska.gov
Good	Melissa	ADF&G	Dutch Harbor	melissa.good@alaska.gov
Gustafson	Rich	ADF&G	Homer	rich.gustafson@alaska.gov
Haaga	Jan	NMFS	Kodiak	jan.a.haaga@noaa.gov
Honnold	Steve	ADF&G	Kodiak	steve.honnold@alaska.gov
Howard	Katie	ADF&G	Anchorage	katherine.howard@alaska.gov
Hulbert	Lee	ADF&G	Juneau	lee.hubert@alaska.gov
Inokuma	Meg	ADF&G	Kodiak	meg.inokuma@alaska.gov
Jones	Wes	NSEDC	Nome	wes.jones@nsedc.com
Kent	Scott	ADF&G	Nome	scott.kent@alaska.gov
Keith	Kevin	NSEDC	Nome	kevin@nsedc.com
Kruse	Gordon	UAF	Juneau	ghkruse@alaska.edu
Lean	Charlie	NSEDC	Nome	charle.lean@nsedc.com
Long	Chris	NMFS	Kodiak	chris.long@noaa.gov
Messmer	Adam	ADF&G	Douglas	adam.messmer@alaska.gov
Morado	Frank	NMFS	Seattle	frank.morado@noaa.gov
Munk	Eric	NMFS	Kodiak	j.eric.munk@noaa.gov
Murawski	Jane	NMFS	Kodiak	jane.murawski
Pengilly	Doug	ADF&G	Kodiak	doug.pengilly@alaska.gov
Olson	Andrew	ADF&G	Douglas	andrew.olson@alaska.gov
Rose	Craig	NMFS	Seattle	craig.rose@alaska.gov
Russ	Elisa	ADF&G	Homer	elisa.russ@alaska.gov
Schwenzfeier	Mary	ADF&G	Dutch Harbor	mary.schwenzfeier@alaska.gov
Shepard	Ric	ADF&G	Kodiak	ric.shepard@alaska.gov
Siddeek	M.S.M.	ADF&G	Juneau	shareef.siddeek@alaska.gov

-continued-

Last Name	First Name	Affiliation	Location	Email
Siddon	Chris	ADF&G	Juneau	chris.siddon@alaska.gov
Sloan	Leah	UAF	Fairbanks	lmsloan@alaska.edu
Smith	Quinn	ADF&G	Douglas	quinn.smith@alaska.gov
Spafard	Marsha	ADF&G	Kodiak	marsha.spafard@alaska.gov
Spalinger	Kally	ADF&G	Kodiak	kally.spalinger@alaska.gov
Stephan	Jeff	UFMA	Kodiak	jstephan@ptialaska.net
Swiney	Kathy	NMFS	Kodiak	katherine.swiney@noaa.gov
Stichert	Laura	ADF&G	Kodiak	laura.stichert@alaska.gov
Stichert	Mark	ADF&G	Kodiak	mark.stichert@alaska.gov
Stratman	Joe	ADF&G	Petersburg	joseph.stratman@alaska.gov
Tamone	Sherry	UAS/UAF	Juneau	sherry.tamone@uas.alaska.edu
Trebesch	Charles	ADF&G	Kodiak	charles.trebesch@alaska.gov
Tschersich	Philip	ADF&G	Kodiak	philip.tschersich@alaska.gov
Urban	Dan	NMFS	Kodiak	dan.urban@noaa.gov
Vanek	Vicki	ADF&G	Kodiak	vicki.vanek@alaska.gov
Webb	Joel	ADF&G	Juneau	joel.webb@alaska.gov
Wessel	Maria	ADF&G	Cordova	maria.wessel@alaska.gov
Worton	Carrie	ADF&G	Kodiak	carrie.worton@alaska.gov
Zepplin	Tim	ADF&G	Dutch Harbor	tim.zepplin@alaska.gov
Zheng	Jie	ADF&G	Juneau	jie.zheng@alaska.gov

Interagency Crab Research Meeting December 13-14, 2012



Location: All sessions will be held in the Harbor Room of the Kodiak Inn

THURSDAY, DECEMBER 13

Morning Coffee 7:45– 8:00 AM

Morning Session 8:00 AM – 12:00 PM

- I. Introductions
- II. Opening Remarks: Chris Siddon, Bob Foy
- III. Meeting Agenda: Modify and Adopt
- IV. Research Review
 - A. Special Topic Session- What are the primary biological and ecological factors and key uncertainties associated with variability in abundance of red king crab?
 - 1. Population Estimation
 - a. Pribilof Islands red king crab – Bob Foy, NMFS Kodiak Laboratory, Kodiak, AK
 - b. What we need for Bristol Bay red king crab: stock assessment viewpoints – Jie Zheng, ADF&G, Juneau, AK (25 min.)
 - c. The other Bering Sea red king crab – Jenefer Bell, ADF&G, Nome, Alaska
 - d. Southeast Alaska red king crab – Adam Messmer and Chris Siddon, ADF&G, Douglas/Juneau, AK
 - 2. Stock Productivity
 - a. Bristol Bay red king crab fecundity, embryo quality, and larval quality. What we know and don't know– Kathy Swiney, NMFS Kodiak Laboratory, Kodiak, AK

Mid-morning Coffee (15 Minutes)

- b. Effects of ocean acidification on red king crab embryos, larvae, and juveniles – Chris Long, NMFS Kodiak Laboratory, Kodiak, AK
- c. Predation of early benthic phase red king crabs– Ben Daly, NMFS Kodiak Laboratory, Kodiak, AK
- d. Advances and future directions in larval and juvenile king crab biology and ecology – Ginny Eckert, UAF SFOS, Juneau, AK
- e. Effects of Climate and Gadid predation on red king crab population dynamics in Alaska – Gordon Kruse, UAF SFOS, Juneau, AK
- f. Report on the qualitative modeling workshop on red king crab recruitment and potential climate change impacts – Gordon Kruse, UAF SFOS, Juneau, AK (15 min.)

-continued-

Lunch: 12:00 PM – 1:00 PM

Afternoon Session: 1:00 PM – 5:00 PM

3. Stock Structure
 - a. RKC genetic stock structure – Stew Grant, ADF&G, Anchorage, AK
4. Harvest (Mortality)
 - a. Ghost Fishing on king crab in Womens Bay – Pete Cummiskey, NMFS Kodiak Laboratory, Kodiak, Alaska
 - b. Gear impacts and bycatch mortality – Craig Rose, NMFS Sand Point Laboratory, Seattle, WA

Mid-afternoon Coffee (15 minutes)

5. Discussion of red king crab research priorities (45 min.)
- B. University of Alaska
1. Tamone Crab Lab: Update on bycatch mortality and terminal Molt in *Chionoecetes* – Sherry Tamone – UAS Biology Dept., Juneau, AK
 2. Population structure and trophic position of snow crab (*Chionoecetes opilio*) in the Alaskan Arctic: contributing to stock assessment data for the AFMP – Lauren Devine, UAF SFOS, Fairbanks, AK

6:00 PM - Dinner at the Old Powerhouse

FRIDAY, DECEMBER 14

Morning Coffee 7:45 – 8:00 AM

Morning Session 8:00 AM – 12:00 PM

- C. University of Alaska (Continued)
1. Kings or zombies? A review of parasitic barnacles infecting king crabs and future research questions – Leah Sloan, UAF SFOS, Fairbanks, AK
 2. Effects of ocean acidification on larval development of Alaskan crabs – Raphaëlle Descoteaux, UAF SFOS, Fairbanks, AK
 3. Interannual variability in transport and connectivity patterns of eastern Bering Sea Tanner crab - Jon Richar, UAF SFOS, Juneau, AK
- D. Alaska Department of Fish and Game
1. Mapping Tanner crab habitat in the Kodiak Area of the Gulf of Alaska – Carrie Worton, ADF&G, Kodiak, AK
 2. An experimental escapement based management system for Alaska pot shrimp fisheries – Quinn Smith, ADF&G, Douglas, AK
 3. Norton Sound red king crab summer commercial fishery CPUE standardization – Gretchen Bishop, ADF&G, Juneau, AK

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Mid-morning Poster Session & Coffee (30 minutes)

4. Registration Area D (Yakutat) Dungeness fishery and recent survey work – Joe Stratman, ADF&G, Petersburg, AK
 5. Aleutian Islands Golden King crab pilot research project conducted during commercial fishing: a first look (10 min.) – Vicki Vanek, ADF&G, Kodiak, AK
 - E. National Marine Fisheries Service
 1. Habitat, predation, competition, and growth: Interactions between juvenile red and blue king crabs – Chris Long, NMFS Kodiak Lab, Kodiak, AK
 2. Crabs of the Chukchi Sea: what we saw this summer – Dan Urban, NMFS Kodiak Lab. Kodiak, AK
 - V. Next Year's Meeting and Special Topic Suggestions
 - VI. Other Business
 - VII. Poster Presentations
 1. Shellfish management aerial surveys using ArcPad 10 in Southeast Alaska – Olson, A. and A. Messmer. Alaska Department of Fish and Game, Douglas, Alaska.
 2. King crab parasites in Alaska fjords: A population study – Nouver, C., A. Olson, and H. Glenner. University of Bergen, Bergen, Norway.
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